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OPERATING EXPERIENCE WEEKLY SUMMARY

Office of Nuclear and Facility Safety

September 3 - September 9, 1999

Summary 99-36

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OEAF FOLLOWUP ACTIVITY

1. OPERATING EXPERIENCE WEEKLY SUMMARY NOW AVAILABLE VIA E-MAIL

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EVENTS

1. UNEXPECTED AIRBORNE RADIOACTIVITY CAUSES PERSONNEL CONTAMINATION

On September 1, 1999, at the Savannah River Site, seven personnel were exposed to airborne radioactivity while performing routine vault operations at the FB-Line Facility. The affected personnel were removing filled, bagless transfer cans from a vault and transferring them to overpack containers in a vestibule area outside the vault. An operator working in the vault noticed dust on one of the cans, and a radiological control operations technician detected 2,000 dpm of removable alpha contamination on the top of the can. The vault operator returned the can to the vault and began to decontaminate it. A high-volume air monitor alarmed at approximately the same time; however, facility personnel have not established a connection between the decontamination of the bagless transfer can and the alarm. The occurrence resulted in positive nasal or saliva smears for seven personnel, and positive chest scans for four personnel. (ORPS Report SR-WSRC-FBLINE-1999-0026)

The vault operator was wearing respiratory protection in accordance with a job-specific radiation work permit. According to the work permit, respiratory protection was not required for personnel working in the vestibule. Immediately following the high-volume air monitor alarm, the vault operator placed the can back onto its rack in the vault, exited the vault, and secured the vault door. A radiological control operations technician removed the planchet from the high-volume air monitor and measured 80,000 disintegrations per minute with an alpha probe. He also measured 140,000 disintegrations per minute of alpha on the filter paper of an air sampler in the vestibule area. Another radiological control operations technician measured alpha contamination on the floor of the vestibule outside the vault door and on the protective clothing of a person who was in the vestibule near the vault door.

All personnel removed their protective clothing, surveyed themselves for contamination at the exit from the controlled area, and detected no contamination. However, when they monitored themselves at a portal monitor, two persons discovered skin and hair contamination. Subsequent nasal and saliva smears measured positive for the vault operator, five persons who were in the vestibule area, and one person who was at the bottom of a stairwell to the vestibule. Four of the seven persons with positive smears elected chelation therapy. (Chelating agents combine with specific substances in the body to encourage elimination rather than absorption and retention.) All affected personnel were administered chest counts the following day, and four measured positive for americium-241. Facility personnel declared the entire third floor of the facility a contamination area to ensure containment of the radioactive material.

Investigators have not identified any procedure or radiation work permit violations that might have caused or contributed to this occurrence, nor have they determined the source of the airborne contamination. Facility personnel are developing a recovery plan that includes controlled re-entry to the stairwell and vestibule and installation of a high-resolution camera in the vault to inspect cans for damage. OEAF engineers will continue to track this occurrence and will provide information on causes and corrective actions as it becomes available.

KEYWORDS: airborne radioactivity, alpha, contamination

FUNCTIONAL AREAS: Materials Handling/Storage, Radiation Protection

2. CRITICALITY INFRACTION AT ROCKY FLATS

On August 24, 1999, at the Rocky Flats Environmental Technology Site, while removing a can of plutonium oxide from a part carrier inside an X-Y retriever, a process specialist discovered that the can had been in direct contact with a plutonium metal part that was also stored inside the part carrier. A criticality safety officer declared a criticality infraction. Another process specialist had incorrectly stored the can of plutonium oxide in the part carrier on August 22 in accordance with oral instructions from his foreman. The foreman did not check the material database to determine if the part carrier was empty before telling the process specialist to move the plutonium oxide can. The foreman should have told the process specialist to store the can on heat detectors inside a nearby glovebox because the part carrier was not the appropriate storage location. Failure to communicate the correct storage location resulted in a spacing requirement violation and a reduction in the criticality safety margin. (ORPS Report RFO--KHLL-PUFAB-1999-0059)

The facility manager held a fact-finding meeting. Meeting attendees learned that the X-Y retriever location and the glovebox had different alpha identifiers but the same numeric identifiers and that the foreman used the alpha-numeric identifiers when he told the process specialist where to store the can. The similar numeric identifiers, combined with the fact that the foreman did not mention that the storage destination was a glovebox, may have contributed to the error. Attendees learned that workers normally tilt part carriers to verify that they are empty before placing any items in them, but this verification process is not required by procedure. They also learned that the process specialist did not tilt the carrier before placing the plutonium oxide can in it. The facility manager directed facility personnel to revise procedures to ensure part carriers are empty before items are placed in them.

NFS has reported criticality violations at Rocky Flats in several Weekly Summaries. Some examples follow.

- Weekly Summary 99-09 reported that a facility safety officer declared a criticality infraction when facility personnel discovered twelve 10-gallon salt residue drums stored against a wall in room A and a row of JH-98 drums stored on the opposite side of the wall in room B. Investigators determined that the criticality safety evaluation does not permit fissile-material storage within 24 inches of JH-98 drums even if separated by a wall. They also determined that different organizations were responsible for performing nuclear safety audits in the rooms and that there was no communication between the two organizations regarding the contents of the rooms or the storage requirements. (ORPS Report RFO--KHLL-371OPS-1999-0007)

- Weekly Summary 98-20 reported that caustic waste treatment operators violated nuclear material safety limits for height and volume when they heaped moist plutonium precipitate in two glovebox pans. The engineers provided the operators with written instructions to level the pans for geometry concerns. However, when the operators leveled the pans, they did not remove the material from the glovebox, and the criticality volume limit for the glovebox remained violated. (ORPS Report RFO--KHLL-371OPS-1998-0033)

- Weekly Summary 96-37 reported that workers had moved drums into a storage area with previously infracted drums, resulting in a criticality safety violation. Corrective actions included improving communications between operations staff and criticality safety engineers. (ORPS Report RFO--KHLL-771OPS-1996-0148)

These events illustrate the importance of operator attention to detail. Workers must assume responsibility for their work and pay attention to detail. In the August 24 event, the foreman did not check the procedure to verify that he communicated the correct storage location to the process specialist, and the process specialist failed to verify that the part carrier was empty. NFS advocates self-checking, a risk management tool designed to reduce the potential for human error. Self-checking requires distinct thought and actions that focus attention at a specific moment before performing a task.

These events also illustrate the importance of having rigorous criticality safety programs. Facility managers and supervisors should ensure that plan-of-the-day meetings or pre-job briefings are performed, the responsibilities of personnel are clearly defined, and the expectations of the task are correctly understood. They should also monitor activities by performing frequent direct observations of specific activities and routine walk-downs.

Facility managers should review the following documents and ensure that all operators and supervisors are familiar with operating procedures and understand their purpose and use. This is even more important when criticality safety issues are involved.

- DOE O 420.1, *Facility Safety*, provides direction on establishing criticality safety program requirements.

- DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities*, chapter IV, “Communications,” requires clear and concise oral instructions and that personnel should repeat oral instructions, as necessary, to ensure that they are correctly understood. The Order also states that operator good practices, including attention to detail, are important to ensure that appropriate facility conditions are maintained.

- DOE-STD-1071-94*, Guideline to Good Practices for Material Receipt, Inspection, Handling, Storage, Retrieval, and Issuance at DOE Nuclear Facilities*, section 3.4.2, discusses the precautions to be considered when moving materials and recommends that personnel who perform this work should be trained using a performance-based program.

- DOE-STD-1031-92, *Guide to Good Practices for Communications*, provides guidance for repeat-back and confirmation in section 4.1, “Oral Instructions and Informational Communications.”

KEYWORDS: nuclear criticality safety, work control

FUNCTIONAL AREAS: Nuclear/Criticality Safety, Operations

3. THERMOCOUPLE WIRING ERROR CAUSES RESEARCH EQUIPMENT DAMAGE

On August 26, 1999, at the Los Alamos National Laboratory LANSCE Accelerator Complex, experimental equipment belonging to the Accelerator Production of Tritium (APT) Technical Project Office suffered thermal damage when it overheated. Electrical heaters adjacent to the equipment were energized with 100 percent current at 480 volts which overheated the equipment resulting in approximately $5,000 of damage to differential temperature transducers, calibration heaters, and wire insulation. Certain thermocouples that provided temperature data to a control system that would de-energize the heaters if temperatures on the test article reached 150 degrees Celsius, had not been wired correctly. When personnel who were observing the experimental equipment discovered temperature indications in excess of 300 degrees, a technician immediately de-energized the heaters. About the same time, an unexpected odor was smelled, and all personnel evacuated the area until air samples revealed that no combustible or radiological hazards were present. Although there were no injuries, the failure to correctly connect the protective thermocouples resulted in equipment damage. (ORPS Report ALO-LA-LANL-ACCCOMPLEX-1999-0020)

The experimental equipment was designed, assembled, bench-tested, and installed at the Los Alamos Neutron Science Center (LANSCE) by LANSCE-7 technicians for radioactive decay heat research on a tungsten target. The experiment involved irradiating a water-cooled tungsten target that was suspended from a steel insert into the LANSCE 1-mA, 800-MeV proton beam.

Actual irradiation occurred in November/December 1998, but DOE cancelled further irradiation experiments. To continue with the decay heat research, technicians installed two sets of four radiant heaters on either side of the steel insert, to simulate beam heating of the target. The insert would be heated to reflect actual conditions when the proton beam was on. Temperatures along the insert would range from 150 degrees Celsius at the bottom to 70 degrees Celsius at the top. APT researchers would then study the heat transfer properties of the apparatus along the steel shielding using water calorimetry in order to improve the error bars on the actual irradiation measurements.

The assembled research equipment consisted of electrical heaters that were connected through controllers to individual, single-phase, 480-volt power supplies. There were four sets of thermocouples (temperature sensors) distributed along the 12-foot length of the insert that were designed to trip the heaters. These thermocouples were plugged into thermocouple connections in an Allen-Bradley control system and a data acquisition unit. There were three over-temperature protections built into the experiment. The Allen-Bradley control system would open the heater circuit breakers if (1) the insert surface temperature reached 150 degrees Celsius, (2) the heater surface temperature reached 550 degrees Celsius, or (3) the air gap on the back side of the heaters reached 175 degrees Celsius. The controllers were designed to either deliver a fixed power level or to control the temperature of the test article at a given setpoint.

At the time of the incident, a LANSCE-7 technician had energized the radiant heaters for approximately 20 minutes before LANSCE and APT personnel arrived to receive operational training on the equipment. Upon arrival, an APT researcher noticed that the experimental data acquisition system was not operating so he turned it on to verify the temperatures indicated by the Allen-Bradley control system. Personnel immediately realized that some of the thermocouples were indicating room temperature while others mounted in the same position indicated temperatures as high as 330 degrees Celsius. The LANSCE technician immediately de-energized all of the heaters. Figure 3-1 shows the damaged wiring and insulation on the top of the steel insert (the damaged area measures approximately 6 inches from right to left).

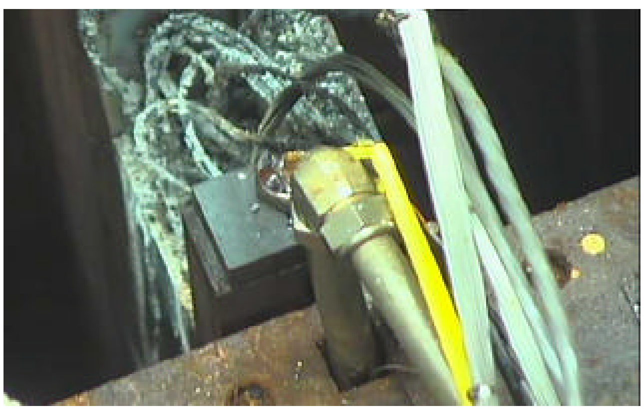

Figure 3-1. Damaged Wires and Insulation

Investigators determined that the thermocouples for the steel insert were not connected to the Allen-Bradley control system. Instead, a technician had mistakenly wired thermocouples from another experimental system into the Allen-Bradley control system from a patch panel adjacent to the one containing the correct thermocouple connections. The thermocouples for the other two over-temperature trips were connected correctly. Investigators determined that although the power supply, the heater controller wiring, the heater face thermocouples, and the air gap thermocouples were verified through inspection and operational testing, the configuration of the installed thermocouples for the over-temperature protection of the steel insert was not. APT managers had identified the possibility of wiring errors in their hazard analysis for the actual beam use. In order to mitigate this hazard, they required that the wiring must be independently checked every time someone worked on it. However, the independent check was not done in this case. They also determined that the equipment was energized and operating before APT researchers, who owned the equipment, were present and that the data acquisition system that provided thermocouple readings was not operating at the time the equipment was energized.

On August 30, 1999, the facility managers conducted a critique of the occurrence and critique attendees raised the following concerns.

- The design of the heating assembly could have benefited from an independent or joint design review. LANSCE-7 personnel confirmed that the components of the heater assembly functioned as expected, but the entire assembly, in conjunction with the research, lacked an in-depth review and evaluation before start-up.
- Although the APT Technical Project Office team had developed a hazard control plan that applied directly to their decay heat research, the same rigorous review and procedural control did not occur during (1) the in-field review of the electrical configuration for the heating assembly, (2) the powering up of the assembly, or (3) the transfer of ownership and operational responsibility to the APT team.
- The APT Technical Project Office team noted that their recent work-related accomplishments could have resulted in complacency on their part with respect to the lack of formality used in preparation for this particular work.

This event underscores the importance of verifying that installed configurations of experimental equipment are correct. Control circuits and trip circuits should be operationally verified to ensure that they are functioning properly. In this case, human error resulted in the incorrectly connected thermocouples. To reduce the potential for human error, managers should ensure that (1) tasks are controlled by procedure, (2) tasks are supported by accurate drawings or diagrams, (3) components or equipment are labeled properly, and (4) verification is performed that demonstrates that the task was performed correctly. This event also identified a lack of formality regarding the assembly, start-up, and transfer of the experiment because project personnel considered the decay heat research an “add-on” experiment. Existing procedures that had been followed during previous APT experiments were not followed for this experiment. Although personnel hazards and appropriate controls had been identified for this experiment, controls for equipment protection were not rigorously considered.

KEYWORDS: configuration control, damage, equipment, experiment, insulation, test, thermal, thermocouple, wire

FUNCTIONAL AREAS: Configuration Control, Research and Development

4. MISPOSITIONED VALVE CAUSES INADVERTENT TRANSFER OF RADIOACTIVE MATERIALS

On August 30, 1999, at the Savannah River Site In-Tank Precipitation (ITP) Facility, operators inadvertently transferred radioactive materials from a waste storage tank into a flush water line during a leak check because of a mispositioned valve. An area radiation monitor near the affected piping alarmed shortly after an operator started a flush water pump. A shift supervisor in the area of the alarming radiation monitor immediately stopped the operation, minimizing the amount of liquid that was transferred. Radiological control operations inspectors measured 100 millirem per hour on contact with a valve near the alarming area radiation monitor, and 25 millirem per hour at 30 centimeters from the valve. They barricaded the area around the valve and posted it as a radiation area. This occurrence is significant because loss of control of system configuration caused an inadvertent transfer of radioactive material. (ORPS Report SR--WSRC-ITP-1999-0021)

Operators at the ITP Facility flushed the affected piping and reduced the radiation level to within a few millirem per hour of normal background. Because the occurrence involved equipment and personnel from the ITP Facility and the tank farm, managers of both facilities held critiques. Participants in the critiques learned that ITP Facility operators were using flush water at approximately 150 psig to check for post-maintenance leaks at a valve and jumper in a waste tank valve box. A special procedure for this task required admitting water pressure at both ends of a flush water line to prevent inadvertent transfer of the tank contents. A tank farm operator who was present at the pre-job briefing cautioned that a normally open valve at the tank farm had been administratively closed and would need to be re-opened before starting the flush water pump. (The tank farm controls portions of the flush water system.) In response to this information, one of the attendees made the notation “V-220” in the prerequisites portion of the special procedure. After the pre-job briefing, ITP Facility operators verified and signed the prerequisites. However, the actual leak check was not started until two days later by a different group of operators. Because a tank farm operator was involved in ongoing duties on that day and could not attend the second pre-job briefing, his supervisor attended in his place. The work group accepted the prerequisites that had been signed off two days earlier, but the note about valve V-220 had no meaning to them. Consequently, when an ITP Facility operator requested a tank farm operator to start the flush water pump, pressure was admitted to only one side of the flush line. The resulting pressure imbalance forced radioactive liquid from the waste tank into a portion of the flush line in reverse direction.

The direct cause of the occurrence was a valve misalignment that established an unexpected flow path. Critique participants identified the following weaknesses in conduct of operations that require corrective actions.

- Two full days elapsed between the time the ITP Facility operators verified prerequisites for the special procedure and the time they actually started the leak check. The facility will evaluate criteria for re-verifying prerequisite conditions including elapsed time, shift changes, and temporary suspensions of procedures.

- Not all persons involved in the task attended the second pre-job briefing. The facility will evaluate the need to postpone tasks until all persons involved can attend briefings.

- The workers who identified the need to open a valve that was not specifically mentioned in the prerequisite portion of the procedure failed to communicate this information positively and clearly to the workers who actually performed the task. The facility will evaluate methods to reduce the risk of error associated with communication failures among work shifts and facilities.

This occurrence underscores the importance of effective communication and proper use of procedures for safe operation. Tasks that continue from one shift or work crew to another and tasks that involve systems controlled by more than one organization have a high probability for error. When an operating crew must transfer an incomplete procedure to another crew, they should use positive communication techniques to ensure that the relieving crew clearly understands the status of the procedure. These techniques may include drawing a line directly below the last step completed and ensuring that detailed status information is included in operating logs and turnover documents. Relieving groups should consider re-verifying prerequisite conditions or verifying the expected status of systems or components. Facility managers should investigate methods to formalize communications between operating organizations with shared responsibilities for tasks.

KEYWORDS: communications, conduct of operations, procedures, prerequisites

FUNCTIONAL AREAS: Conduct of Operations, Operations

5. NRC CONCERNED WITH MISLEADING MARKETING INFORMATION FOR GENERALLY-LICENSED RADIOACTIVE MATERIAL

This week OEAF engineers reviewed Nuclear Regulatory Commission (NRC) Information Notice 99-26, *Safety and Economic Consequences of Misleading Marketing Information*. The NRC issued the information notice on August 24, 1999, to alert licensees and addressees of a possible threat to public safety caused by misleading marketing information and lack of end-user understanding of regulatory requirements regarding products that contain small quantities of authorized radioactive materials. Examples of such products are self-luminous exit signs, precision balances, thickness gauges, and density gauges. Watches and clocks may incorporate radioactive gas in dials, hands, or faces that allow them to be read in the dark. The NRC anticipates that users of these products will review the information in the notice for applicability to their marketing, sales literature, and management practices. Distributors and manufacturers of generally-licensed products should provide information to their customers so that they are fully aware of regulatory responsibilities associated with use, transfer, and disposal of radioactive products before acquiring them. (NRC Information Notice 99-26)

Radioactive products distributed under a general license are required to be inherently safe so that untrained people can use them. However, licensed devices that contain radioactive material have not always been disposed of or handled properly, particularly those authorized by general licenses. This has resulted in radiation exposure to the public and expensive decontamination of property. As shown in the following examples, routine inspections of licensees by NRC staff found that some distributors and manufacturers do not appear to completely understand the regulations and their responsibilities.

- Some vendors have marketed and distributed products that were not in accordance with their application for safety evaluation and registration of the product.

- Some manufacturers are unclear as to what changes should be identified or what differences between the registration certificate and current design should be brought to the attention of the product user through marketing literature updates and mass distributions or other forms of communications.

- Some manufacturers failed to notify product users that deviations from the stated marketing literature, approved design, and processes could cause (1) the product to fail prematurely, (2) the product to be unable to survive its intended conditions of use, or (3) the radiation safety features of the product to be ineffective.

Many times the manufacturers and distributors of these radioactive products portray them to prospective customers as non-maintenance items that can be bought off the shelf, installed without any consideration to special circumstances or safe location, and forgotten about. Product-related literature can provide misleading information or information that can easily be misconstrued by omission or commission. An example of such literature that was brought to the attention of the NRC states: "...the easiest to install, zero-maintenance building exit signs in existence. They can literally be screwed into place and forgotten for up to 20 years. The low installed cost is the last cost for the guaranteed life of the sign." This type of advertising language could suggest to the end-user that their responsibilities are over after they install the device. However, the user, as a general licensee, is responsible for the device until it is safely returned or disposed of according to regulatory requirements.

Within a 6-month period in 1997, two separate incidents occurred where damaged exit signs caused significant contamination. In one incident, a young boy found three exit signs powered by radioactive material at a building demolition site near his home. The boy brought the signs home and broke one to examine it, contaminating a portion of his home and its contents. In another incident, a mentally-impaired boy at a state-run adolescence psychiatric hospital shattered an exit sign. Self-luminous exit signs typically contain 9 curies of tritium. Each of these incidents resulted in temporary relocation of the residents while the facilities were decontaminated at a cost in excess of $200,000 per incident. Exit signs powered with radioactive material that are forgotten about or left unattended for a long period of time are often the direct result of misleading information. These exit signs contribute to an increased risk of incidents that could result in substantial decontamination costs.

The NRC reminds manufacturers and distributors of the problems that could arise when radioactive products sold through misleading or inexact marketing result in the improper control, transfer, damage, disposal, or discarding of radioactive material. Section 20.2001 of 10 CFR Part 20 Subpart K, “Waste Disposal,” specifies general requirements for disposal of licensed material. Because of the nature of the licensed material contained in a device, currently one of the options for disposal of licensed material is to transfer products containing radioactive material to an authorized recipient, as specified in 10 CFR 20.2001(a). Manufacturers and distributors of products licensed to 10 CFR Part 32, *Specific Domestic Licenses to Manufacture or Transfer Certain Items Containing Byproduct Material*, or by an Agreement State should inform the end-user that disposal of radioactive products must occur by transfer to an authorized licensee. Authorized recipients of the used products for disposal are either the original suppliers of the device or a commercial firm, licensed by the NRC or an Agreement State.

Clear understanding of regulations and availability of accurate and complete information are key to ensuring public safety. General licensees that possess these types of products have responsibilities, but many times do not clearly understand them until an accident forces them to do so. Often the chemical form of the source is mentioned by name, but the advertising text fails to mention that the source is radioactive and that owners of these types of devices are licensed to possess them. Avoidable accidents resulting from lapses in responsibilities and accountability can burden members of the public or agencies having jurisdiction over radioactive materials and can result in substantial costs involved in cleaning up such accidents. In a recently proposed rule (July 26, 1999; Volume 64 of Federal Register, page 40295), the NRC would require licensees that distribute products containing radioactive material to provide information to their customers before purchase or transfer of such products. The information would include a list of services that must be offered to users, information on disposal options including a cost estimate, and if the user is located in an Agreement State, the name, address and the phone number for the appropriate Agreement State contact.

KEYWORDS: exit, radiation protection, radioactive material, regulations, sign

FUNCTIONAL AREAS: Licensing/Compliance, Radiation Protection

6. POWER LINE MINIMUM SAFE DISTANCE VIOLATIONS

On September 2, 1999, at the Hanford Site, Spent Nuclear Fuels Project operations personnel determined that a trailer carrying a Multi-Canister Overpack (MCO) violated OSHA requirements for the minimum safe distance from power lines because the top of the MCO was less than the OSHA minimum safe distance of 16 feet from 230-kV power lines. Also, on September 1, a worker from the maintenance training organization ascended a ladder on the trailer to observe the MCO. Because the worker was not trained to perform work near power lines, he was in violation of the OSHA standard. The worker mentioned to a co-worker that he felt a tingling sensation as he climbed the ladder, and the co-worker reported this information to the operations shift manager. The worker returned home at the end of his shift and did not seek medical attention. Violations of minimum safe distance requirements from power lines have resulted in injuries and deaths at DOE facilities. (ORPS Report RL--PHMC-SNF-1999-0026)

The top of the MCO on the trailer was 17 feet, 6 inches above the ground, and the power line is approximately 31 feet above the ground. This made the distance from the top of the MCO to the power line approximately 13 feet, 6 inches. OSHA standards require a minimum distance of 16 feet between 230-kV power lines and unqualified employees or mechanical equipment.

Operations personnel evaluated the incident on September 2 and determined that the placement of the trailer violated site procedures because no one notified Electrical Utilities at least 48 hours before moving equipment taller than 14 feet under the overhead power lines. They also determined that OSHA requirements for minimum safe distances from power lines for unqualified workers and mechanical equipment were violated. Operations personnel moved the trailer away from the power lines, and the project maintenance manager briefed all drivers on the incident.

OEAF engineers found a similar incident involving failure to allow a safe distance from power lines. A contract worker for the Western Area Power Administration was injured when the OSHA requirements for minimum safe distance from power lines were violated. On October 23, 1992, the contract worker felled a tree near a power line. As the tree fell, it passed within 2 feet of the line, and current from the line flashed over to the tree. The fault current traveled down the tree to the stump, entered the workers leg, and passed through his foot to the ground. He was rendered unconscious momentarily. Physicians treated him for electrical burns and released him on October 25. After experiencing continued back pain, he visited a specialist on November 19 who discovered six cracked ribs. Investigators determined that no one had defined a safe working distance from the power lines. (Type A Accident Investigation Board Report on the October 23, 1992 Nonfatal Electrical Contact at the Ault-Craig 345 kV Transmission Line Tree Removal Project near Steamboat Springs, Colorado)

These events demonstrate the importance of exercising extreme caution when working in the vicinity of overhead power lines. DOE facility managers should ensure that facility personnel and off-site vendors who operate equipment on site property are aware of any overhead power lines. Truck drivers, especially those moving oversized loads, should evaluate all overhead hazards. The following references address minimum safe distances from exposed, energized electrical equipment and power lines.

- 29 CFR 1910, Subpart S, "Electrical," provides a table for determining the minimum elevation of exposed, energized parts above a working space. It also states that only qualified persons shall have access to installations with exposed, energized parts.

- OSHA 3075, *Controlling Electrical Hazards*, provides an overview of basic electrical safety for individuals with little or limited training or familiarity with electrical hazards and states that unqualified employees and mechanical equipment must be at least 10 feet away from overhead power lines. If the voltage is more than 50 kV, the clearance must be increased by 4 inches for each additional 10 kV.

In general, OSHA’s electrical standards are based on the National Fire Protection association’s standard NFPA 70E, *Electrical Safety Requirements for Employee Workplaces*. OSHA references may be found at http://www.osha-slc.gov/.

KEYWORDS: industrial safety, job planning, overhead, power line, safety hazard

FUNCTIONAL AREAS: Industrial Safety, Work Planning

7. WORK ORDER VIOLATION EXPOSES CARPENTER TO ROTATING-EQUIPMENT HAZARD

On August 30, 1999, at the Idaho Nuclear Technology and Engineering Center, a maintenance carpenter was exposed to a rotating-equipment hazard while adjusting a nearby scaffold railing. He was exposed to an unguarded blower motor fan belt because he did not place his personal lock and tag on the blower motor lockbox as required by a work order. The carpenter’s supervisor told him to lower a paint shop scaffold railing because it was blocking the blower motor switch box that electricians needed to access. Because work orders are not typically issued for scaffold modifications, the carpenter moved the railing without knowing that a work order had been issued or that it required him to install his personal lock and tag on the existing lockout/tagout. The facility manager placed a hold on the job until an investigation could be completed. Although there were no injuries from this incident, installing a personal lock and tag in accordance with the work order would have provided a positive barrier to protect the carpenter from the rotating-equipment hazard. (ORPS Report ID--LITC-LANDLORD-1999-0012)

Investigators determined that when the electricians reviewed the work order before they accessed the scaffold to begin repairing electrical safety switches for ventilation system blower motors, they discovered that a previous work order step was not signed as completed. The electricians told the carpenter that he forgot to sign a previous work order step which required him to (1) contact safety personnel and obtain a safe work permit, (2) install a personal lock and tag on the fan motor, (3) adjust the scaffold railing, and (4) inspect the scaffold. However, the carpenter told the electricians that he had not performed the actions as defined in the work order step nor had he known that a work order had been issued for the job. Figure 7-1 shows the electrical box and the blower motor with the fan belt. Figure 7-2 shows an overall view of the scaffolding.

Figure 7-1. Electrical Box and Blower Motor with Fan Belt

Figure 7-2. Scaffolding

The facility manager held a critique on this event. Critique members learned that the supervisor did not tell the carpenter that a work order was issued and that the carpenter did not have any reason to believe that one would be required. They learned that work orders are not typically required for scaffolding modifications or inspections and that certification tags are typically used to document these tasks. They also learned that the carpenter did not realize that the exposed fan motor belt was a potential hazard while he was adjusting the railing. In addition, critique members learned that the general intent section of the work order stated that steps one through four were to be performed in sequence. However, the supervisor directed the carpenter to perform work order step three at the same time painters were performing step four. Electricians later noticed that step four was signed as completed, but that step three was not signed. After the electricians told the carpenter that he had not signed step three, they realized that he had not installed his personal lock and tag on the lockbox which was in violation of the work order and the site lockout/tagout procedure.

NFS has reported rotating-equipment hazards in several Weekly Summaries. Some examples follow.

- Weekly Summary 98-43 reported that a building maintenance machinist and a vendor representative at the Rocky Flats Environmental Technology Site had performed work on a turbine generator without a lockout/tagout in place.

Investigators determined that (1) no one performed a physical verification to ensure that a lockout/tagout was installed, (2) the vendor representative was not qualified to oversee the work that was performed, and (3) the maintenance supervisor and the vendor representative did not ensure that the work package was followed. (ORPS Report RFO--KHLL-371OPS-1998-0077)

- Weekly Summaries 98-22 and 98-13 reported that an electrician at the Ames Laboratory Technical and Administrative Services Facility was severely injured when part of his clothing became entangled with a rotating shaft on a supply fan. The electrician was airlifted to a regional hospital, where doctors performed lifesaving surgery, as well as subsequent surgery to save his arms. A Type B Accident Investigation Board identified failure to identify the exposed, rotating-shaft hazard and lack of an Integrated Safety Management program as the root causes of the event. (DOE/CH-AI98E, *Type B Accident Investigation Board Report on the March 27, 1998, Rotating Shaft Accident at Ames Laboratory Ames, Iowa*, April 1998; ORPS Report CH--AMES-AMES-1998-0002)

These events underscore the importance of recognizing and guarding against hazardous, rotating equipment. The U.S. Department of Labor/Bureau of Labor Standards Bulletin, *The Principles and Techniques of Mechanical Guarding*, states: "Any rotating object is dangerous. Even smooth, slowly rotating shafts can grip clothing or hair. Accidents due to contact with rotating objects are not frequent, but the severity of injury is always high." In this event, facility personnel identified the fan belt as a rotating hazard, but the supervisor failed to tell the carpenter of the hazard. He also failed to tell the carpenter that a work order existed for the work. If the work order had been followed, this event could have been prevented. The supervisor also directed personnel to perform the work order steps in parallel violating the work order requirement to perform the steps in sequence.

Pre-job briefings, facility procedures, and training programs should emphasize the dangers associated with mechanical activities. Plan-of-the-day meetings or pre-job briefings should be held so that work responsibilities are clearly defined and that the expectations of the task are understood. Facility personnel responsible for industrial safety should conduct periodic walk-downs to identify potential hazards. Facility managers and personnel in charge of industrial safety should review the following guidance, and ensure that they are reflected in work control programs.

- DOE O 4330.4B, *Maintenance Management Program*, section 8.3.1, provides guidelines on work control systems and procedures. The Order states that work control procedures help personnel understand the necessary requirements and controls. Section 3.4 identifies the elements of a maintenance management program that ensures planning, control, and documentation of maintenance.

- 29 CFR 1910.212, *General Requirements for all Machines*, states that methods of machine guarding shall be provided to protect employees from hazards such as rotating parts and that the guard shall not be an accident hazard itself. OSHA regulations can be found at http://www.osha-slc/.

- OSHA publication 3067, *Machine Safeguarding*, 1992, developed to aid in the protection of workers against the hazards of moving machine parts, states: "any machine part, function, or process which may cause injury must be safeguarded." It also states that when the operation of a machine or accidental contact can injure personnel in the vicinity, the hazards must be either controlled or eliminated. This publication describes various hazards of mechanical motion and presents some techniques for protecting workers. It is available at http://www.osha-slc/Publications/Mach_SafeGuard/.

KEYWORDS: rotating equipment, lockout and tagout, scaffold, fan belt

FUNCTIONAL AREAS: Industrial Safety, Modifications

FINAL REPORT

This section of the OEWS discusses events filed as final reports in the ORPS. These events contain new or additional lessons learned that may be of interest to personnel within the DOE complex.

1. SELF-ASSESSMENT IDENTIFIES DEFICIENCIES IN NUCLEAR CRITICALITY SAFETY PROGRAM

On August 27, 1999, at the Oak Ridge East Tennessee Technology Park, facility managers for the K-33 Gaseous Diffusion Building released the results of an Integrated Safety Management System (ISMS) self-assessment of compliance with their Nuclear Criticality Safety Program (NCSP). The self-assessment identified examples of (1) operating instructions and instruction guides that have not been adequately reviewed to ensure integration of nuclear criticality safety requirements, (2) nuclear criticality safety requirements that have not been fully implemented in work tasks, (3) improper posting and labeling of fissile-material containers, (4) materials in arrays with insufficient spacing, and (5) insufficient criticality alarm coverage during work processes. The facility managers immediately corrected deficiencies in ongoing work processes, and criticality safety personnel reviewed the deficiencies against safety analyses to confirm that there were no losses of double-contingency protection. Project managers imposed a one-day stand-down of fissile-material operations, and facility supervisors received retraining on the requirements of the NCSP and the use of the nuclear criticality safety analyses. The self-assessment allowed facility managers to address an increasing trend of problems associated with the implementation of NCSP requirements before the problems became more serious. (ORPS Report ORO--BNFL-K33-1998-0006)

The retrained supervisors briefed work crews on the deficiencies, corrective actions, and lessons learned from the self-assessment during toolbox training sessions and pre-job briefings. The supervisors and their crews then conducted job-specific assessment critiques of their own work areas to assess compliance with the NCSP, applicable nuclear criticality safety analyses, and work instruction requirements. They also prepared checklist-style job aids that consolidate the requirements from numerous documents to ensure that work practices were compliant with the NCSP.

The facility managers who performed the ISMS self-assessment found a series of contributing causes for the deficiencies.

- The facility did not have a sufficient number of qualified nuclear material handlers to ensure that a handler was present at all fissile-material operations. Qualified nuclear material handlers receive additional training on the requirements of nuclear criticality safety analyses and fissile-material storage areas. Facility managers permanently assigned a nuclear material handler to every work crew to improve overall operations and work crew management.

- Operations foremen and supervisors, who were less qualified than the nuclear material handlers, relied on the handlers to perform fissile-material storage area operations without direct and qualified supervision. Facility managers now require the foremen and supervisors to be trained and qualified as nuclear material handlers to ensure that they are knowledgeable about fissile-material storage area operations.

- Operators and supervisors did not perform frequent self-assessments to ensure continued compliance with fissile-material storage area requirements or to correct minor deficiencies before they became more serious. Facility managers will require operators to perform weekly self-assessment inspections of all fissile-material storage areas. This requirement will provide timely feedback to work crews regarding their work practices. The feedback will also improve the crews' understanding and execution of fissile-material operations.

The facility managers determined that the direct and root causes for the program deficiencies were a management problem. Managers and supervisors failed to disseminate the requirements of the NCSP in a manner that could be understood and applied at the working-task level. Although double-contingency technical requirements were addressed in work-task documents, workers and supervisors had to cross-reference several implementing instructions to ensure compliance with all required criticality safety requirements. They had difficulty following all the steps and requirements of the program and complying with the controls and criticality safety contingencies required for each work task. Facility managers developed a new, integrated, criticality safety instruction that made these requirements more accessible by consolidating them into a single document. They also developed another integrated instruction for operations personnel that consolidates the nuclear criticality safety analyses requirements for fissile-material storage area operations and storage arrays.

The Price-Anderson Amendments Act (PAAA) Senior Review Board for the project met to consider whether the deficiencies identified in the self-assessment constituted a reportable non-compliance with 10 CFR 830, *Nuclear Safety Management*. The board determined that although double-contingency protection was never lost, the self-assessment revealed a weakness in the NCSP that should be reported as a potential PAAA non-compliance.

Facility managers developed and implemented a total of 24 corrective actions that address the identified deficiencies in the NCSP. Among these actions, facility managers now require all fissile-material operating instructions to be reviewed by criticality safety experts to ensure that nuclear criticality safety analyses requirements are adequately incorporated. Through the self-assessment process, they determined the following lessons learned.

- An effective self-assessment program can identify problems or deficiencies in the implementation of a safety program early in the process, potentially avoiding a situation where the deficiencies result in a more serious impact on facility safety. In this case, the managers conducted a self-assessment after noticing an increasing trend of similar problems associated with the implementation of NCSP requirements. They addressed the problems before they became more serious.

- Technical requirements in complex work environments need to be disseminated at the task level in an integrated manner to facilitate their effective implementation. Personnel are more likely to miss a task-related technical or safety requirement if they must research the requirements from multiple documents. The use of checklist-type job aids can also be an effective tool in assisting work crews to follow complex requirements correctly.

KEYWORDS: assessment, fissile material, integrated safety management, nuclear criticality safety, operating procedures, Price-Anderson Act

FUNCTIONAL AREAS: Decontamination and Decommissioning, Management, Nuclear/Criticality Safety

OEAF FOLLOWUP ACTIVITY

1. OPERATING EXPERIENCE WEEKLY SUMMARY NOW AVAILABLE VIA E-MAIL

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